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Rooting Pattern of Coconut (*Cocos nucifera* L.)*

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ABSTRACT

The rooting pattern of coconut palms growing in three situations viz. regular cultivation and manuring, regular cultivation alone, and under neglect was studied. It was found that palms receiving regular cultivation and manuring produced the highest number of roots (4016). About 74 per cent of the roots produced did not have lateral spread beyond 2 m from the bole. Regular cultivation reduced root proliferation in the top 30 cm layer of soil. Most of the roots were confined to the 31st to 120 cm depth.

These findings are useful in formulating agronomic practices. For obtaining highest efficiency in the uptake of nutrients, fertilizers should be applied in circular basins having 150 to 180 cm radius and 15 to 20 cm depth. In the interspaces of coconut, inter and mixed crops can be successfully grown.

The coconut palm has an adventitious root system, typical of a monocot. It produces almost throughout its life uniformly thick roots having a diameter of 8 to 10 mm. These are the main roots which branch freely and produce numerous fine branch roots of one to two mm in diameter. The branch roots are short lived. Sampson (1923) counted upto 3620 main roots in a 60-year old palm. Patel (1938) found that a 45-year old palm has 6855 main roots. Copeland (1931) stated that in the Philippines the number of roots in a middle aged palm, varied from 4000 at 7000. A majority of these roots are confined to a depth of about three to four feet socording to Patel (Loc. cit). Menon and Pandalai (1960) reported that the lateral pcread of the roots depend on the environmental conditions and that the roots are strongly disposed to keep to the direction they start with.

These studies mainly aimed at determining the total number of roots produced, the maximum distance individual roots traversed or the depth they penetrated. But for a more purposeful assessment of the root distribution, as related to agronomic practices, it is the location where maximum concentration of the functioning roots occur that is of importance.

With this objective, the following study was taken up.

MATERIALS AND METHODS

Three plots which were under an observational trial from 1919 in a sandy loam soil was selected for this purpose. The palms in plot I received the annual dose of fertilizers and green leaf applied in circular basins along with the usual cultural operations, *viz.* ploughing twice a year. In plot II the palms were not given any fertilizers but were given the cultural operations as in plot I. The third plot was left neglected with neither manuring nor cultural operations.

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Representative palms from the middle of each of these three plots were selected for the study. A sector one-sixth of the full circle to a distance of 3.75 and depth of 1.5 m. was separated out by excavating the soil from the three sides of the sector. The soil was then washed away, taking care to retain the exposed roots in position by means of ropes and stakes. Counts were taken of the mains roots at radial distances, *viz.* near the bole, 1 m, 2 m, 3 m and 3.5 m and depths *viz.* 0.3 m, 0.6 m, 0.9 m, 1.2 m and 1.5 m. The roots were then cut from the bole and fixed on an expanded metal frame retaining the natural position (Fig. 1). This was repeated in the plot II and III also (Figs. 2 and 3). The data collected are presented in Tables 1, 2 and 3.

Table 1—Root distribution (one-sixteenth) of a middle aged coconut palm receiving regular cultivation and manuring

Distance from the bole	Near the bole		1 m		2 m		3 m		3.5 m	
Depth from surface	No. of roots	Percentage	No. of roots	Percentage	No. of roots	Percentage	No. of roots	Percentage	No. of roots	Percentage
0-30 cm	23	9.1	4	1.5	8	3.1	5	1.9	5	1.9
31-60 cm	93	37.0	29	11.5	18	7.1	9	3.6	4	1.5
61-90 cm	71	28.2	29	11.5	15	5.9	5	1.9	4	1.5
91-120 cm	42	16.7	35	13.9	13	5.1	10	3.9	6	2.4
121-150 cm	22	8.7	22	8.7	11	4.3	9	3.5	4	1.5
Total	251	100.0	119	47.0	65	26.0	38	15.0	23	9.0

Table 2—Root distribution (one-sixteenth) of a middle aged coconut palm receiving regular cultivation alone

Distance from the bole	Near the bole		1 m		2 m		3 m		3.5 m	
Depth from surface	No. of roots	Percentage	No. of roots	Percentage	No. of roots	Percentage	No. of roots	Percentage	No. of roots	Percentage
0-30 cm	24	12.9	—	—	4	2.1	24	2.1	2	1.1
31-60 cm	64	34.2	29	15.5	15	8.0	45	2.7	4	2.1
61-90 cm	46	24.6	26	13.9	17	9.1	18	9.6	8	4.3
91-120 cm	38	20.3	15	8.0	17	9.1	12	6.4	1	0.5
121-150 cm	15	8.0	28	15.0	6	3.2	9	4.8	6	3.2
Total	187	100.0	98	52.0	59	32.0	48	26.0	21	11.0

Table 3—Root distribution (one-sixteenth) of a middle aged coconut palm under neglected condition.

Distance from the bole	Near the bole		1 m		2 m		3 m		3.5 m	
Depth from surface	No. of roots	Percentage	No. of roots	Percentage	No. of roots	Percentage	No. of roots	Percentage	No. of roots	Percentage
0-30 cm	21	10.3	13	6.4	5	2.5	—	—	—	—
31-60 cm	105	51.7	33	16.2	12	5.9	3	1.5	1	0.5
61-90 cm	38	18.7	2	1.0	4	2.0	4	2.0	3	1.5
91-120 cm	26	12.8	14	6.9	8	3.9	6	3.0	1	0.5
121-150 cm	13	6.4	8	3.9	3	1.5	3	1.5	3	1.5
Total	203	100.0	70	34.0	32	16.0	16	8.0	8	4.0

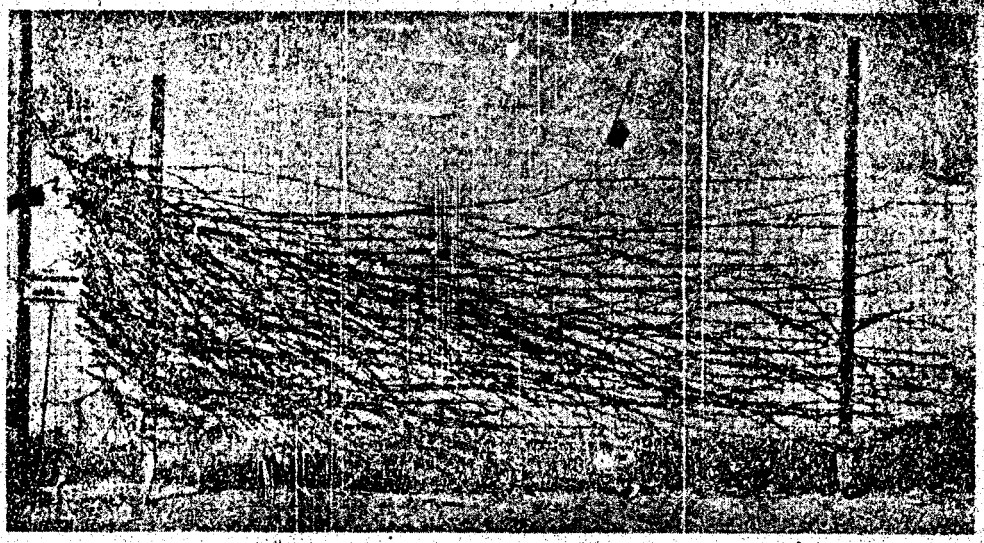

Fig. 1. Rooting pattern of coconut in the regularly cultivated and manured plot.

Fig. 2. Rooting pattern of coconut in the neglected plot.

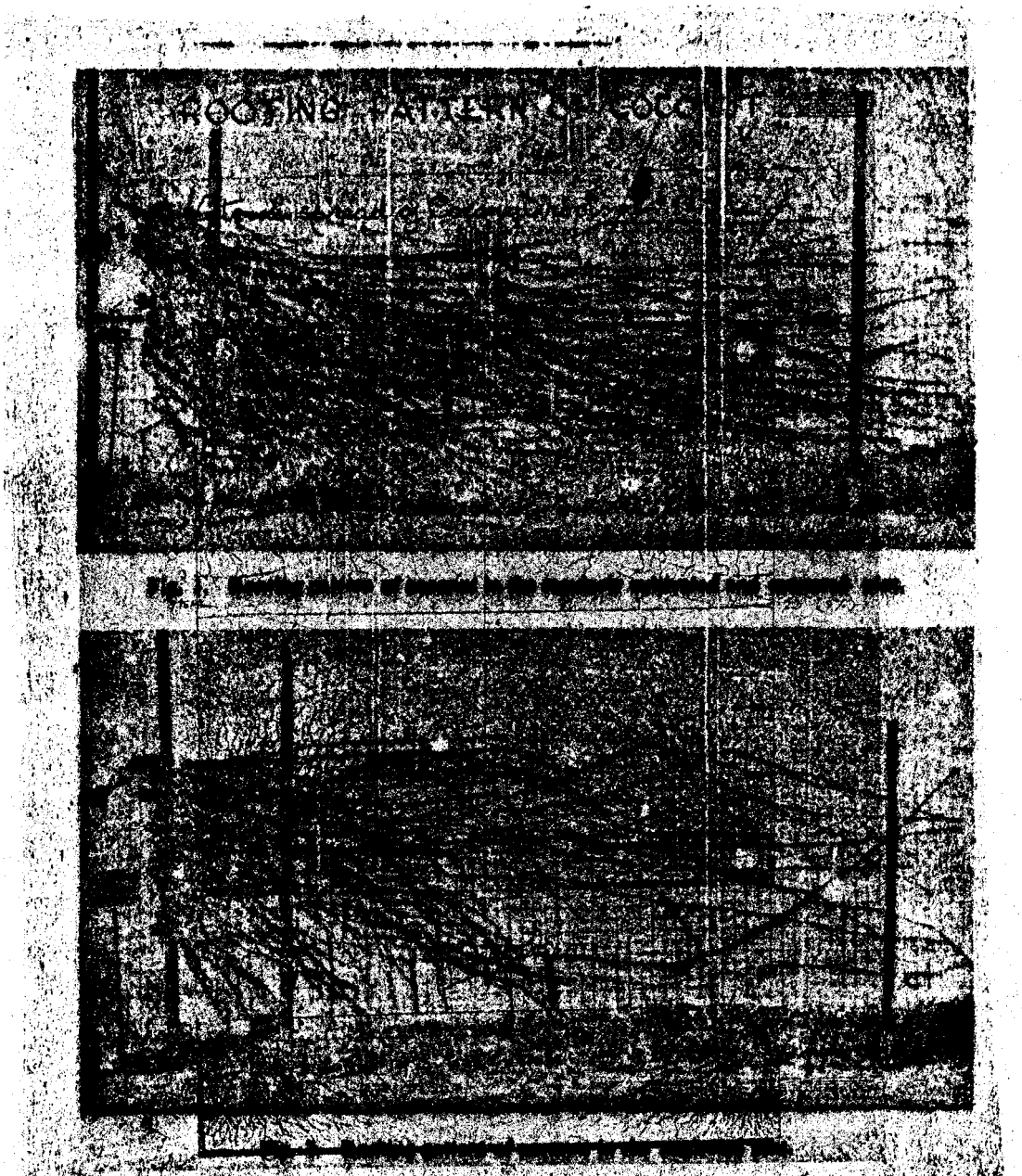

Fig. 3. Diagramatic representation of rooting pattern of coconut palm in a well maintained garden.

RESULTS AND DISCUSSION

The study showed that the mean number of roots produced by palms receiving regular cultivation and manuring, regular cultivation alone and no cultivation and no manuring were (251 × 16) 4016, (187 × 16) 2992, and (203 × 16) 3248 respectively. The percentage number of roots found in the top 30 cm layer soil is quite negligible. Over 82 per cent of the roots of the palm in the regularly cultivated and manured plot was found in the 31 to 120 cm depth and only 8.7 per cent of the roots went below 120 cm. Regarding the lateral spread of the roots 74 per cent of the roots emerging from the bole did not extend beyond 2 metres. It was seen that 68 per cent of the roots of the palm in the cultivation alone plot and 84 per cent of the roots of the palm in the neglected plot did not extend beyond 2 m from the bole. The data also showed that regular cultivation and manuring had induced increased root production and that the surface rooting of coconut had been considerably reduced by the regular cultural operations.

Similar observations were recorded in the root studies carried out at Veppankulam (*Anon.* 1970). It was found that a great majority of the roots were confined to the 16-60 cm layer of soil and that the number of roots produced by the palm increased with the increase in the level of fertilizers applied.

Since coconut and arecanut belong to the same family (Palmaceae) it is relevant to examine the rooting habit of arecanut.

Bavappa and Murthy (1961) while describing the morphology of the root of arecanut palm, found that the roots were concentrated within 60 cm to 90 cm round the base of palm. Bhat and Leela (1969) reported that 61 to 67 per cent of the roots of arecanut palm were found within a radius of 50 cm and few roots extended beyond 100 cm. They also found that 66 to 79 per cent of the roots were met within a depth of 50 cm of the surface.

Studies made in Ceylon (*Anon.* 1969) using radio isotope technique to determine the efficiency of fertilizer utilisation by coconut palms showed that the efficiency is greater when placed 10 cm or lower than on surface. The efficiency of uptake of nutrients was the greatest at a lateral distance of 50 cms and it decreased with increase in radial distance, it being negligible (6·4 per cent) beyond 2 m. This indicates that the root activity is many times more within a radius of 2 m and a depth of 10 to 45 cms. The activity of the roots being directly proportional to the number of functioning roots in the location, these studies confirm the present finding that a large proportion of the roots are confined within a radius of 2 m and depth of 90 cm.

These findings are of much importance in formulating agronomic practices like fertilizer application and raising inter and mixed crops in coconut plantations. To obtain the highest efficiency in nutrient uptake, the fertilizers and manures should be applied in circular basins having 150 to 180 cm radius and 15 to 20 cm depth. As the recommended spacing for coconut in the square system of planting is 7.5 m by 7.5 m, and the root activity of the coconut palm is negligible beyond 2 m over 75 per cent of the land is untapped by the coconut roots. This opens up vast scope for growing annual or perennial crops in the interspaces of coconut plantations.

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